

Hotspot Analysis of Bus Accidents for LA County METRO
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ABSTRACT

ISSI partnered with the Los Angeles County Metropolitan Transportation Authority (METRO) to create an Accident Analysis tool. The tool was created to provide METRO with a semi-automated way to analyze and map bus accidents that have occurred over a thirteen-month period. The application was developed to work with ArcGIS 9.1 and ArcSDE connecting to an Oracle database, which is running on an AIX machine. The Accident Analysis tool allows METRO to create points for every accident in a particular month. Geocoded points are appended to an existing ArcSDE layer, which holds historic accident data. The accident points for the desired month are displayed in ArcMap using a definition query, which, filters out the historic points and symbolizes the accidents based on the type of accident that occurred. Spatial Analyst is used to create polygons that show accident clusters for the previous thirteen months. An additional layer that shows system wide accident hotspots as points is also created and added to the display. The mapping portion of the tool uses ISSI's automated mapping tool to generate maps for each bus division. The maps depict where and what type of accident has occurred within the thirteen month time period.

INTRODUCTION

Los Angeles County Metropolitan Transportation Authority's (METRO) Service Performance Analysis Division is responsible for assuring the highest level the safety for its bus riders and the public. Through the analysis of recent bus accident history, METRO was able to identify significant safety issues and determine areas where measures can be taken to reduce the number of incidents. Essential details are collected and stored in METRO's Transit Safe application and analyzed monthly.

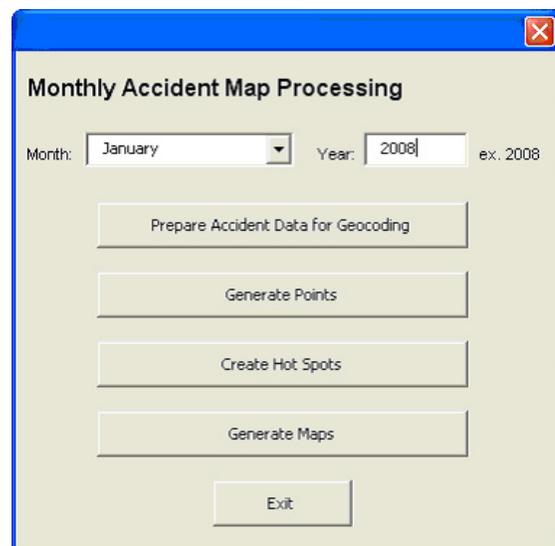
METRO bus accident information data is derived from Transit Safe and stored in Vehicle Accident Management System (VAMS). The accident data was processed monthly using four SPSS modules and ESRI's ArcGIS 9.1 software for geocoding and manual map creation. ESRI's ArcGIS Publisher extension was utilized to create published map files for each of the eleven bus-operating divisions from ArcMap documents. These published maps were viewed via the Intranet by METRO staff using ArcGIS Desktop products. Previously, the entire process was very labor intensive and took approximately four to five days to complete.

ISSI created the Accident Analysis tool in order to automate the process of analyzing and mapping bus accidents and to ensure consistency throughout the mapping process. According to Jeff Neely, Sr. Administrative Analyst for METRO's Service Performance Analysis Department, "The Accident Analysis tool has proven to be both a time-saving and accuracy-ensuring application. The monthly preparation time for producing the accident maps for our 11 bus-operating divisions was about 4 to 5 days. That time has been reduced to approximately 1 to 2 days. As regards accuracy, the 11 maps are created programmatically; the opportunity for error has been greatly reduced."

The primary data behind the Accident Analysis tool is an accident feature class. This feature class contains historic METRO accident occurrences that date back to November 2007. When the Accident Analysis tool is launched, it makes a backup copy of the accident feature class with a time stamp prior to processing data. This backup can be restored should there be a problem during the course of action.

THE INTERFACE

The Accident Analysis tool was developed in VB and runs with ArcGIS 9.1 and ArcSDE connecting to an Oracle 10g database running on an AIX machine. When the tool first opens, the user is prompted for their username and login. The user must then select a month and enter a year for processing. The application verifies that a valid



month and year have been entered and checks to see if accident data currently exists for the selected time period. Once validation occurs, the user can proceed through the four processing tools: Prepare Accident Data for Geocoding, Generate Points, Create Hot Spots, and Generate Maps.

PREPARE ACCIDENT DATA FOR GEOCODING

This first step, Prepare Accident Data for Geocoding, takes raw data from the Transit Safe table stored in Oracle and prepares it for geocoding. This table contains all of the accident information recorded at the time of the occurrence. Each record within this table contains a unique attribute, "Accident Report Number". This attribute will be used throughout the process for identification purposes. The output from this first step consists of two Oracle tables, "Intersection" and "Between". The "Intersection" table represents accidents that occurred at an intersection. The "Between" table represents accidents that occurred on a particular street in between two cross streets. During the data collection process, when an accident occurs between two cross streets, two fields are populated with cross street information (Cross Street 1 and Cross Street 2). The Oracle table is queried, based on these fields, to determine which records represent intersection and between values. Two new tables are created for the month being processed. One table is made up of all the Intersections accidents returned from the query and the other consists of all of the Between accidents returned from the query. If an accident is identified as "Between", a duplicate of that record is created in order to make sure that Cross Street 1 and Cross Street 2 are represented in the data.. These duplicated records contain the same Accident Report Number.

GEOCODING

The second step in the Accident Analysis process involves manually geocoding the "Intersection" and "Between" tables that were created in step one. Geocoding is performed by METRO using a Thomas Brothers road network geocoding service. ISSI considered automating the geocoding process. However, identifying accident occurrences requires intimate knowledge of bus routes and schedules. For this reason, it was decided that METRO would manually geocode the accident data each month.

GENERATE POINTS

Generating points from the manually geocoded accidents is the third step in the Accident Analysis process. These points are generated from the “Intersection” and “Between” tables that have been geocoded by METRO staff. For those accidents that occurred at an intersection, an event theme is created from the xy values. These accidents are appended to the existing historic Accidents feature class located within Oracle. Processing the accidents that occurred between two intersections is a bit more involved. A query selects the two geocoded points based on the Accident Report Number. A single record is created for each unique Accident Report Number and a point is placed at the midway between the two intersections on the appropriate road. These records are then appended to the Accident feature class.

Once all of the points have been generated, the Accident feature class is loaded into the current map session. A definition query is applied which allows only the current months accident points to be visible. Accidents are displayed for review by METRO symbolizing accidents by type. The user validates the location of the points, makes necessary adjustments, and re-generates the points if necessary.

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- March 2008 Accidents
 - Right Turn Accidents
 - Left Turn Accidents
 - Collision wth Parked Vehicle
 - Collision wth Fixed Object
 - Hit By Vehicle
 - Side Swipe Accidents
 - Straight Ahead Accidents
 - Other Accidents

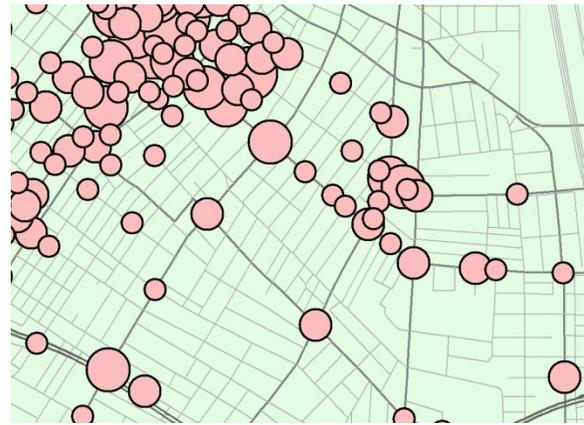
CREATE HOT SPOTS

Formerly METRO analyzed the previous thirteen months of accident data and displayed areas of high accident concentrations as graduated symbols. This was a mathematical analysis,, using coordinate values rather than a spatial analysis. ISSI recommended using Hot Spot analysis to generate polygons that would represent the distribution of accident concentration area. The Hot Spot Analysis tool calculates statistics for each feature in the Accident database, creating a raster dataset that tells us where features with high or low values cluster spatially. There are a main steps needed to acheive the desired output are these geoprocessing tools: Collect Events, Hot Spots, and Kernal Density.

The Hot Spot tool requires weighted points rather than individual incidents. The first step in obtaining this information is to extract the previous thirteen months of data from the accidents feature class based on the user selected month and year. Collect Events which is part of the Spatial Statistics tool is then used to create a new shapefile containing weighted point data. This new shapefile is created with a field named "Count" which holds the sum of all incidents for each unique geographic location. The images below illustrate the results of the Collect Events process.



Input (Accidents)



Output (Collect Events)

Now that there is a shapefile with a single point for each unique geographic location, we can use the Hot Spot Spatial Statistics tool. Given the set of weighted data points, Hot Spot Spatial Statistics identifies clusters of points with values higher than you would expect to find by random chance. The output of the Hot Spot function is a point shapefile that contains a score for each feature. This score represents the clustering of accident incidents for a specific distance. A high score is an indication that the neighboring accidents also have high attribute values.



Input (Collect Events)

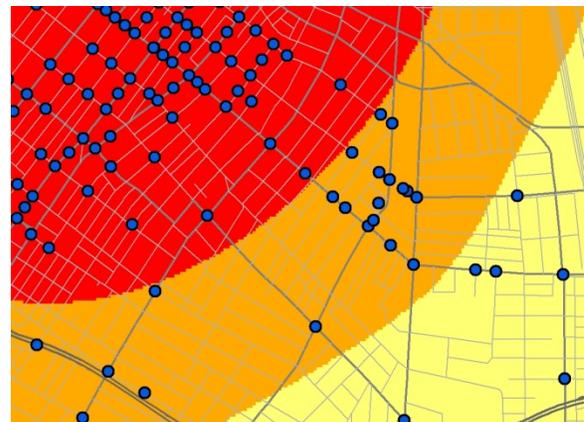


Output (Hot Spots)

The final step of the process uses the Kernel Density tool, which is available through the Spatial Analyst extension. Kernel Density calculates a magnitude per unit area from each hot spot feature using a kernel function. Only the accidents that fall within a certain distance are considered in calculating the density. If no accidents fall within the distance of a particular cell, the cell is not assigned a value. An output cell size of 50 is used for our calculation purposes. The output from the Kernel Density analysis is a seamless raster file displaying areas of high accident occurrences. After the raster dataset has been created, it stored within the Oracle database.



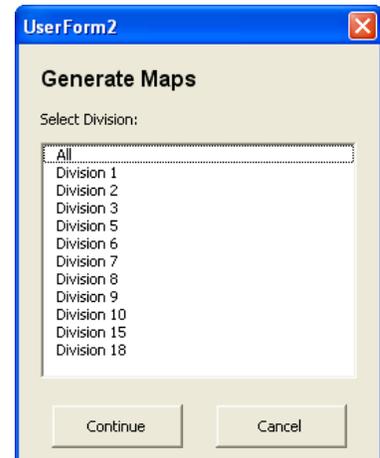
Input (Hot Spots)



Output (Kernel Density)

GENERATE MAPS

The final step in the Accident Analysis process is the generation of maps for company wide viewing. At the end of each month, accident analysis maps are generated for each of the eleven divisions. When the user clicks the Generate Maps button, a selection interface appears prompting the user to select the division for which they want to generate maps. The user can choose to generate maps for one, many, or all divisions. The end products include an ArcMap project (mxd) and an ArcReader published map file (pmf) for each division.



When a division is selected, the extent of the maps will be set to that of the appropriate set of accident points. These points will be symbolized based on their accident type. The data within each .mxd also includes hot spot points and polygons from the past thirteen months. The hot spot point features are symbolized using a graduated symbol and color while the polygons are symbolized by a graduated color scale. Background information such as roads, cities, and ocean are used for reference.

A map is generated for each district using a customized B-Size Landscape templates. These templates include a standard map components consisting of a scalebar, north arrow, Thomas Brothers logo, disclaimer, METRO logo, and legend. The templates also automatically place the appropriate map title including the division and time period for which the analysis was run.

We ran into a few problems when using ArcPublisher to export the maps to .pmf. First, the export to pmf function does not recognize a layer definition query. We originally used the historic Accident feature class with a definition query defining the appropriate month and division. The export to pmf function simply exported all points and did not take into account the definition query. We were forced to export the accidents for each division and store them as separate shapefiles. Another unforeseen problem was ArcPublishers inability to package the hot

spot raster file from SDE. We were also forced to export the raster to a local directory before publishing the document.

Using the ArcPublisher extension, a .pmf files is created for each division. These .pmf files are then placed on a central server where they can be accessed by throughout METRO. These files are viewed by management to aid in decision making processes.

